Paediatric complicated pneumonia: Diagnosis and management of empyema

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Abstract
Pneumonia can be complicated by an empyema, progressing from an exudative effusion, to a fibrinopurulent stage with loculations, and then organized with a thick fibrinous peel. The predominant causative organisms are Streptococcus pneumoniae, Staphylococcus aureus (including methicillin-resistant S aureus) and Streptococcus pyogenes. Recently, an increased incidence of paediatric complicated pneumonia has been reported. For diagnostic imaging, a chest radiograph followed by a chest ultrasound is preferred. Computed tomography chest scans, with associated radiation, should not be routinely used. Antibiotic coverage should treat the most common causative organisms. Additional invasive or surgical management is recommended to reduce the duration of illness in cases not promptly responding to antibiotics or with significant respiratory compromise. Choice of management should be guided by best evidence and local expertise. Video-assisted thoroscopic surgery or insertion of a small-bore percutaneous chest tube with instillation of fibrinolytics are the best current options.

Key Words: Chest tube; Complicated pneumonia; Empyema; Fibrinolytics; Paediatric

Pneumonia is one of the most common reasons for hospitalization in childhood. Although most bacterial pneumonia will resolve with treatment of the underlying infection, some cases will be complicated by the development of an empyema, defined as intrapleural pus or a moderate to large exudative parapneumonic effusion (stage 1), which can progress to being loculated (stage 2) with further development of a fibrinous peel (stage 3). Small parapneumonic effusions are common and do not require drainage. Although other complications of pneumonia occur (eg, pulmonary abscess or necrotizing lung), those topics are beyond the scope of the present document. The most common pathogens in this setting, in an immunocompetent host, are Streptococcus pneumoniae, Staphylococcus aureus and Streptococcus pyogenes (group A streptococcus). Methicillin-resistant S aureus (MRSA) has emerged as a significant pathogen [1][2]. Recent studies have reported an increased incidence of paediatric complicated pneumonia [3][4], potentially in part as a result of the emergence of nonvaccine serotypes of pneumococcus since the introduction of the heptavalent pneumococcal conjugate vaccine (PCV7) [5][6].

Clinical presentation
Children with complicated pneumonia will present with many of the symptoms and signs of uncomplicated pneumonia including tachypnea, fever, cough and respiratory distress. The patient may present with complicated pneumonia or an initially uncomplicated pneumonia that is poorly responsive to antibiotics (persistent fever after 48 h to 72 h of antibiotics without clinical improvement, persistent or worsening respiratory distress and/or hypoxia, or new clinical findings of a pleural effusion). Findings on examination that are consistent with a pleural effusion include decreased breath sounds, decreased chest expansion and dullness to percussion of the affected side.
Diagnosis

A chest radiograph (CXR) should always be the initial imaging modality. Ultrasound provides a noninvasive, radiation-free modality to confirm the presence of a pleural effusion suspected on CXR. As well, ultrasound can estimate the size of the effusion, and differentiate free-flowing effusions from those that are loculated [7]. Chest computed tomography is associated with significant radiation exposure, and generally does not alter management or predict outcomes; therefore, it should not be performed routinely [8]. However, chest computed tomography should be considered if an alternative diagnosis, such as malignancy, is suspected. Repeat CXRs are not necessary unless clinical deterioration is evident. When drainage of fluid is clinically indicated, the fluid should be sent for bacterial culture. The yield from pleural fluid cultures is low because most children have already received antibiotics; however, molecular tests, such as pneumococcal polymerase chain reaction, may increase yield if available [9]. Blood cultures are positive in only a minority of cases (approximately 10%), but they should be collected before antibiotics are administered to potentially guide the choice of antibiotics for children who are sufficiently ill to be hospitalized for pneumonia [3]. Sputum culture is occasionally helpful if available, but is usually difficult to obtain.

Management

Management of empyemas is a controversial area. In addition to antibiotics, procedural interventions to drain the pleural space are often warranted to expedite resolution of complicated pneumonias. Conservative management with antibiotics alone may prolong hospitalization. Early procedural intervention is recommended if the patient is in moderate to severe respiratory distress [10] (worsening tachypnea, work of breathing and/or hypoxia) because the pleural fluid often occupies most of the hemithorax and may even cause mediastinal shift. Early consultation with a paediatric surgeon or interventional radiologist is recommended.

Choice of antibiotics

Antibiotics remain a key component in the medical management of empyema, with initial parenteral therapy to cover the most common pathogens, usually followed by oral therapy. Antibiotic coverage for likely causative organisms is essential. There are no randomized trials pertaining to the choice of antibiotics, so the potential choice of agents should be guided by local antimicrobial policies that consider susceptibility patterns, specifically the prevalence of penicillin/cefuroxime-resistant Streptococcus pneumoniae and MRSA. One suggested initial empirical antibiotic choice, in the absence of a confirmed organism, would be cefotaxime or ceftriaxone, with some experts adding clindamycin to better cover anaerobic infection or community-acquired MRSA. Adding vancomycin (or linezolid) in place of clindamycin is another option, and is usually reserved for culture-proven or severe suspected MRSA pneumonia. Although no evidence exists for the recommended duration of treatment for empyemas, a total of three to four weeks’ duration is reasonable if there is adequate drainage and no evidence of additional complications. The switch to oral antibiotics is appropriate when drainage has been completed, and the patient is clinically improving and off oxygen (ie, at or just before discharge). Appropriate oral antibiotics vary depending on local resistance patterns, but a common option is amoxicillin–clavulanate. Refer to Table 3 of the Canadian Paediatric Society’s practice point on pneumonia for antibiotic dosages [11].

It is not uncommon for children with empyemas to have fevers that persist for more than 72 h on appropriate therapy; if the child is otherwise improving clinically, it is usually not a sign of treatment failure.

Choice of procedural intervention

A variety of procedural interventions are used in Canada for the management of empyema. These include chest tube placement with or without fibrinolytics, repeated thoracentesis, video-assisted thoroscopic surgery (VATS) and open thoracotomy with decortication. Although there is still ongoing controversy and a need for additional randomized trials, the best evidence suggests that either VATS, early thoracotomy or small-bore percutaneous chest tube placement with instillation of fibrinolytics (CTWF) results in the best outcomes as measured by hospital length of stay [12]-[17]. CTWF may be the most cost-effective choice [18]. Clinicians should consider local expertise in interventions (eg, a surgeon experienced in performing VATS or an interventional radiologist able to insert a small-bore pigtail catheter), and parental and patient preference when deciding on a treatment. Although most studies have used urokinase as a fibrinolytic agent in CTWF, this agent is not currently available in Canada. Therefore, an alternative
agent is tissue plasminogen activator (at a dose of 4 mg in 30 mL to 50 mL of normal saline daily for up to three days) [19].

**Prognosis/Outcome**

Complete recovery of pulmonary lung function with normalization of the CXRs is expected in the majority of children with complicated pneumonias. In a small number of patients, lung function testing has revealed minor abnormalities of both a mild restrictive [20] and mild obstructive [21] nature, although even these patients demonstrated normal exercise tolerance. Children should be followed after discharge until they have clinically recovered and their CXRs have returned to near normal, recognizing that the latter may take several months [22][23]. Repeating the CXR at two to three months is reasonable.

**References**
